from protozoan cell to highest vertebrate in the course of geologic ages, he let 40 weeks (reduced to hours) represent geologic time—say 20 or 40 million years. For the third term in the proportion he took the number of hours it was necessary to observe the embryonic development in order to detect an appreciable change, and obtained for an answer as the fourth term a number in years which was much longer, even when the shortest lengths of geologic time were taken, than our historic period.

So that it was clear there was plenty of geologic time for evolution to proceed at a pace so slow that it could not be detected within the historic period and still accomplish its perfect work.

When it comes to attempts to estimate geologic time in years it seems to me that most persons must agree that they are not very satisfactory. This is particularly so with those of the physicists who have assumed as a basis for their calculations an origin for our planet, no longer looked upon with much favor in the light of the facts which support the planetesimal hypothesis. These calculations have also been largely invalidated by discoveries relating to the radio-activity of matter.

Of all geologic time estimates, those based upon rate of denudation, and its correlative—the rate of deposition of stratified rocks, seem least unsatisfactory. When these methods are applied to precambrian time it is admitted they amount to little more than wild guesses.

And yet we know that evolution was well on its way before the beginning of Cambrian time.

Walcott has brought to light in the Canadian Rockies abundant evidence of a rich and by no means lowly organized marine fauna at the very beginning of Cambrian time.

He and others estimate that at least 90 per cent. of the total evolution to the present had taken place before the Cambrian period.

Le Conte, even before he had had the benefit of these discoveries, was impressed with the high type of the Cambrian faunas.

His memorable words in this connection are:

> When the curtain goes up on geological history at the beginning of the Cambrian Period we find practically all the subkingdoms of the animal kingdom present and ready to answer to the roll call.

In the light of these facts what vistas of practically unrecorded geologic time filled with evolutionary process are opened up to us!

Bold indeed is he who from a rate of development predicated upon that observed during the brief span of the historic period would assert that geologic time is too short for a gradual evolutionary process.

ARTHUR M. MILLER

STATE UNIVERSITY,
LEXINGTON, KY.

POTASSIUM CYANIDE AS AN INSECTICIDE

READING the article of Professor Fernando Sanford in the October 9 issue, I would add that I have found potassium cyanide very effectual in killing ants in lawns, and it does its work without killing the grass. A half ounce in 6 to 8 quarts of water applied with a sprinkling pot is enough for a nest 18 or 20 inches across.

W. G. BLISH

SCIENTIFIC BOOKS

Dialogues concerning Two New Sciences. By GALILEO GALILEI. Translated from the Italian and Latin into English by HENRY CREW and ALFONSO DE SALVIO, of Northwestern University, with an introduction by ANTONIO FAVARO, of the University of Padua. New York, The Macmillan Company. 1914. Pp. xxi + 300. Price $2.00 net.

In these dialogues Galileo presents the results of his investigations in mechanics and physics. His representative, Salviati, speaking either for himself or as the reader and expositor of the manuscript of a certain unnamed academician—of course Galileo once again—is the principal speaker, and the source of most of the valuable original ideas. Sagredo, the more learned of the other two interlocutors, occasionally contributes something of importance. Simplicio, as an interested layman, raises the objections which would occur to such a man, and gives occasion for the introduction of alternative ex-

planations or illustrations. In presenting such new and revolutionary views as these of Galileo the dialogue form is really the best that could have been used. It enables the author to consider the questions he treats from various points of view and to answer objections or confirm and enlarge upon his propositions, and to do this in an interesting way. The literary skill with which Galileo uses the advantages which the dialogue affords him is remarkable.

The discussion of the first and second day is devoted to the subject of the resistance which solid bodies offer to fracture. On the first day the talk is not very systematic. Salviati introduces the subject by calling attention to a fact known to all practical men, though seemingly forgotten by the philosophers, that a large structure built of the relative dimensions of a small model is not of the same relative strength, but is always weaker; and declares his intention of proving the relations which must obtain among the dimensions of such structures in order that they shall be of equal strength; but he soon drifts off into other matters. Not to mention them all, we find in this book a discussion of the *horror vacui,* in which is described the famous experiment which showed that a suction pump will not lift a column of water more than eighteen cubits, and in which Salviati describes an experiment to determine the limits of the *horror vacui;* a most interesting discussion of infinitesimals and of infinites; an experiment to determine the velocity of light; a study of the resistance which the air offers to a body moving through it, with a clear statement about the terminal velocity, and the general relation of this to the weight and surface of the body; experiments to determine the specific gravity of air; the isochronism of the pendulum and the relation between its period and its length; and lastly the relation of the pitch of a musical tone to the frequency of the vibration, demonstrated and illustrated by beautiful observations. The range of Galileo's interests and the acuteness of his thought can not be better appreciated than by a study of this book.

On the second day Salviati, after giving Galileo's famous demonstration of the law of the lever, goes on to a more formal study of the relations of the dimensions of beams to their breaking strength.

The third and fourth day are devoted to the study of the motion of bodies. The discussion is the one that is familiar to every one from its use in text-books of mechanics. On the third day the subject considered is linear motion with constant acceleration on inclined planes. On the fourth day it is the path of projectiles. Both these books contain, besides the fundamental propositions which are well known and are still used, a great number of others of less importance, which nevertheless serve to show Galileo's fertility of invention and geometrical skill.

This outline of their contents will show why it was worth while to translate Galileo's Dialogues into English. The book is a recognized classic in physics. The freshness and beauty of the thought and the importance of the matter are unsurpassed. It is a book which should particularly be examined by students of physical science at a stage in their progress at which the appreciation of the great original work of the present day would be impossible. It will bring such students at once into a range of thought which they can understand and will illuminate the arid wastes of the text-books in mechanics with the light of genius.

The translators have succeeded remarkably well in preserving the lightness and grace of the style without sacrificing accuracy of expression. The language used by Galileo is so unsystematic that it must have been often difficult to give the proper equivalents to his words and phrases. One suspects that the correct rendering of a word had sometimes to be determined by geometry. Without being pedantic about it, the translators have tried to use the modern technical equivalents of Galileo's less accurate words, and have succeeded so well that the book can be read easily by any one who has the slightest knowledge of mechanics. The beginner will probably once in a while agree with Simplicio in his rueful

complaint that the author "keeps on assuming that all of Euclid's theorems are as familiar and available as his first axioms, which is far from true." The occasional brief notes of the translators are helpful in the full understanding of the text.

The Dialogues were published in 1638, when Galileo's life was nearly at an end, but it is shown by Professor Favaro in the scholarly introduction which he contributes to this edition, that most of the discoveries described in them were made many years before, while Galileo was at Padua.

The book is printed in a manner worthy of its contents. The diagrams and illustrations are reproductions of the originals. In publishing this translation the authors have done a service to all English-speaking students of the history of physics.

W. F. MAGIE

Chemistry and Its Borderland. By ALFRED W. STEWART, D.Sc., lecturer on organic chemistry in the Queen's University of Belfast, etc. With 11 illustrations and 2 plates. Longmans, Green and Co. 1914. Pp. xii + 314. Price $1.50 net.

The scope of this book is best shown by giving the titles of the fifteen essays of which it consists. They are: The Ramification of Chemistry, The Allies of Chemistry among the Sciences, The Relations between Chemistry and Industry, Immuno-chemistry and some Kindred Problems, Colloids and the Ultramicroscope, The Work of the Spectroscope, Chemistry in Space, The Inert Gases and their Place among the Elements, Radium, Niton, Transmutation, The Nature of the Elements, Chemical Problems of the Present and Future, The Methods of Chemical Research, and The Organization of Chemical Research.

The first three of these essays, as well as the last three, appeal most interestingly to the general non-technical reader. The others, which deal with special developments of chemistry, would hardly be intelligently read by those who have no chemical training, but they do serve well to give the chemist a comprehension of the work that is going on in other branches of his specialty. These particular chapters are, however, somewhat lacking in clarity, especially that on immuno-chemistry. It is difficult to describe advanced work in any chemical field in easily comprehensible language, and a failure to put the theories of Ehrlich and Metchnikoff successfully into popular language is not to be wondered at. Perhaps it is hardly worth while to try.

The essay on Chemical Problems of the Present and Future presents an interesting discussion of the part to be played by chemistry in energy and food supply. As possible developments along the line of sources of energy are suggested more efficient storage batteries and primary batteries, improved methods of utilizing solar radiations, artificial coal, the use of explosives in gas engines, and the use of radium. In discussing food supply the question of fertilizers is dwelt upon, with comments on the annual loss of $80,000,000 in the nitrogen of sewage carried into the sea. The future use of the seaweeds of the Sargasso Sea is mentioned and a good description is given of the fixation of atmospheric nitrogen in the electric furnace. A second division of the food problem is the discovery of new supplies. These may be materials which have hitherto, as foods, gone to waste, as oleomargarine, or they may be synthetic foods. At present the latter are too expensive to be thought of, but processes for their manufacture on a large scale may some time be discovered. This leads the author to a brief discussion of the possible synthetic production of living tissue.

> We have the means of building up more and more complex protein derivatives, and, sooner or later, we shall probably synthesize substances quite as complex as the natural protoplasmic materials; when this point is reached, unless our knowledge of "vital" reactions has considerably advanced, we shall at best be in the position of a watchmaker who has constructed a watch but has forgotten to make any contrivance for winding it up. At this point, chance might enter into the problem, and the protoplasmic machine we have designed might spontaneously set itself in motion, but more than this we are not entitled to